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Determination of optimal angle of needle insertion for successful caudal block in pediatric patients by comparing conventional method versus ultrasound guided method: A randomized comparative experimental study

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Abstract

The benefits of regional anaesthesia in children are well documented. These include attenuation of the stress response, reduced opioid requirement and therefore reduction in associated side effects, improved postoperative analgesia, and earlier extubation. Caudal epidural block is one of the most common regional techniques in paediatric anesthesia. Caudal block is safe and reliable technique, easy to perform and has been found to be very effective in children, especially in infra-umbilical surgeries when combined with general anaesthesia. This study included 72 children, of both genders, coming for various elective infra-umbilical surgical procedures such as herniotomy, orchidopexy, circumcision etc. Ethical clearance from institutional ethical committee was obtained. Informed consent was obtained from the parents before including the children in the study. Optimal calculated needle angle for successful caudal block was 28.14±4.03 degrees in Group A, 19.22±2.78 degrees in Group B, which was statistically significant. Needling time or procedural time for successful caudal block was 5.97±1.32 seconds in Group A, 14.25±2.93 seconds in Group B, which was statistically significant.

Keywords: Optimal angle of needle insertion, caudal block, pediatric patients

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Introduction

Pain is a protective mechanism to alert the body to injurious stimuli. Historically, children have been under-treated for pain and painful procedures because of the wrong notion that they neither suffer nor feel pain, or respond to or remember the painful experiences to the same degree the adults did. And now it has been well established that nociception occurs in neonates also [1].

The society of Paediatric anaesthesia, on its 15thannual meeting at New Orleans, Louisiana (2001) clearly defined alleviation of pain as a "basic human right", irrespective of the age, medical condition, treatment, a primary service response for the patient care or medical institution [2].

The benefits of regional anaesthesia in children are well documented. These include attenuation of the stress response, reduced opioid requirement and therefore reduction in associated side effects, improved postoperative analgesia, and earlier extubation [3].

Caudal epidural block is one of the most common regional techniques in paediatric anesthesia. Caudal block is safe and reliable technique, easy to perform and has been found to be very effective in children, especially in infra-umbilical surgeries when combined with general anaesthesia. It allows rapid recovery from anaesthesia with good post-operative analgesia [4].

Success of caudal block depends on proper placement of needle into the space. Traditional methods such as the "whoosh" test, nerve localization, neuro-stimulation and fluoroscopy techniques are the methods which can be used to identify the caudal [5].

space before the injection of medications but these have significant failure rates. The failure rate of placement of needle into the caudal epidural space can be upto 25%.

Crighton IM *et al*. analysed the anatomy of this area in children using MRI. According to their studies, successful entry into the caudal canal is most likely to be achieved via the upper third of the sacrococcygeal membrane [6].

Although most authors recommend that the same needle angle be used during sacral puncture for adults and children, i.e. at 60-90_to the skin, some have commented that the use of this angle is neither safe nor reliable.

Ultrasound is becoming an important adjunct in regional anaesthesia, allowing real-time imaging of nerves and their surrounding structures. This not only increases rates of achieving a successful block, by allowing visualisation of the injectate entering the correct plane, but can also reduce complication rates as surrounding structures can be avoided.

This study is to estimate the optimal angle of needle insertion for successful caudal block by comparing conventional method versus ultrasound imaging and thereby decreasing risks.

Methodology

This study included 72 children, of both genders, coming for various elective infra-umbilical surgical procedures such as herniotomy, orchidopexy, circumcision etc. Ethical clearance from institutional ethical committee was obtained. Informed consent was obtained from the parents before including the children in the study.

Pre-Anaesthetic assessment

All patients were visited on the pre-operative day and a detailed general physical examination, systemic examination including airway and spine examination was done. Baseline parameters like heart rate, blood pressure were noted. Relevant laboratory investigations were done. Informed consent was obtained from the parent.

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Pre-operative fasting

Pre-operative fasting for solid foods was started 6 hours, breast milk for 4 hours, clear fluids for 2 hours before surgery.

Procedure

Inside operation theatre SPO_2, NIBP, ECG monitors were attached. Following induction of anaesthesia with using 8% Sevoflurane in 50/50% oxygen/nitrous oxide an appropriate sized I-gel was placed and IV line was secured. Inj Atropine (15mcg/kg), Inj. Midazolam (0.5mg/kg) and Fentanyl (2mcg/kg) was given. Patient was in spontaneous ventilation via Jackson Rees circuit. The rate of inhaled gases during anaesthesia was adjusted as follows: oxygen/nitrous oxide 50/50% with Sevoflurane value of 1-1.5vol%.

Then the patients were rotated to left lateral recumbent position. After iodine containing skin preparation and draping caudal block was given; one with the conventional method (Group A) the other (Group B) using ultrasound guide (GE LOGIQe portable ultrasound machine, GE 12L-RS linear probe 5-13HZ), and all patients will receive 1ml/kg of 0.25% Bupivacaine.

In group A(conventional method) After identifying the sacral hiatus, a 24 or 23 G hypodermic needle with its bevel facing anteriorly was inserted at an angle of 60-70° to the skin till the sacro-coccygeal membrane was pierced, when a distinct-pop was felt. The needle was now lowered to an angle of 20° and advanced 2-3 mm to make sure that the entire bevel was inside the space. Confirmation of the needle point being in the epidural space was done with the-whoosh test. Then the angle was measured between skin and the needle as shown in figure after negative aspiration for blood and CSF, to rule out intravascular or subarachnoid placement of needle the drug was injected,

Results

Table 1: Calculated needle angle

Group	Mean	SD	*P* value	Statistical significance
A	28.14	4.030	0.001	Significant
B	19.22	2.789		

Optimal calculated needle angle for successful caudal block was 28.14±4.03 degrees in Group A, 19.22±2.78 degrees in Group B, which was statistically significant.

Table 2: Needling time

Group	Mean	SD	*P* value	Statistical significance
A	5.97	1.320	0.001	Significant
B	14.25	2.931		

Needling time or procedural time for successful caudal block was 5.97±1.32 seconds in Group A, 14.25±2.93 seconds in Group B, which was statistically significant.

Table 3: Number of puncture attempts

Group	Mean	SD	*P* value	Statistical significance
A	1.17	0.378	0.137	NS
B	1.06	0.232		

Numbers of puncture attempts were 1.17±0.37 in Group A, 1.06±0.23 in Group B, which was

statistically not significant.

Table 4: Post op HR

Time interval (in minutes)	Group A Mean ±SD	Group B Mean ±SD	*P* value	Statistical significance
0	88.67±5.722	89.61±6.276	0.507	NS
30	88.56±5.729	88.33±6.837	0.882	NS
60	89.36±5.362	88.53±6.376	0.550	NS
90	88.42±4.397	88.08±6.618	0.802	NS
120	89.86±5.330	88.86±7.228	0.506	NS

The immediate post op mean heart rate was 88.67±5.72 beats/min in Group A and 89.61±6.27 beats/min in Group B, after post op duration of 60 minutes89.36±5.36 and 88.53±6.37beats/min in Group A and Group B respectively. There was no statistically significant difference of values between the groups at any point of time.

Table 5: Post-Op MBP changes

Time interval (in minutes)	Group A Mean ±SD	Group B Mean ±SD	*P* value	Statistical Significance
0	78.03±4.760	78.58±4.625	0.617	NS
30	78.81±5.036	78.81±5.036	1.000	NS
60	76.42±3.046	76.44±3.047	0.969	NS
90	78.36±4.716	78.33±4.745	0.980	NS
120	81.14±3.127	81.14±3.200	1.000	NS

The immediate post op Blood pressure was 78.03±4.76 mm of Hg in Group A and 78.58±4.62 mm of Hg in Group B and at post op 60 minutes 76.42±3.04 mm of Hg and 76.44±3.04 mm of Hg in Group A and Group B respectively. There was no statistically significant difference of values between the groups at any point of time.
Significant changes in heart rate seen in the groups at any time interval during.

Table 6: Post-OP SpO_2 changes

Time interval (in minutes)	Group A Mean ±SD	Group B Mean ±SD	*P* value	Statistical Significance
0	99.83±0.378	99.75±0.554	0.459	NS
30	99.81±0.525	99.83±0.447	0.810	NS
60	99.72±0.615	99.89±0.398	0.177	NS
90	99.97±0.167	99.94±0.232	0.562	NS
120	99.89±0.319	99.86±0.351	0.726	NS

In Groups A and B, the mean O_2 saturation ranged from 99.72±% to 99.94%. There was no statistically significant difference of values between the groups at any point of time.

Discussion

Optimal calculated needle angle in our study for successful caudal block was 28.14±4.03 degrees in Group A (conventional method), 19.22±2.78 degrees in Group B (Ultrasound guided group), which was statistically significant.
The angle calculated in our study by ultrasound guided method was similar to study conducted by Park JH *et al.* [7] where the median calculated angle for the needle was 21.0[10-38]0 to the skin to avoid puncture of the bone and potential intraosseous injections.

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According to the study conducted by Shin KM *et al*. [8] on comparing conventional method in CM group (two step technique with initial right angle to skin sacral canal) with the parallel technique in NM group (200 to the skin) The failure rates at the first attempt were not different between both the groups for each anaesthesiologist even though the NM group demonstrated a lower failure rate than the CM group on the basis of a statistically insignificant decrease in the incidence of bloody taps. They demonstrated a decrease in the time required to perform a "one-step" block and an encouraging (but not statistically significant) absence of bloody tap compared with the conventional technique.

Even though the angle difference in our study is statistically significant, clinical significance is questionable.

Needling time or procedural time is the time between the needle's contact with skin and removal from the skin of caudal block.

In the present study needling time or procedural time found was 5.97±1.32 seconds in Group A (conventional method), 14.25±2.93 (Ultrasound guided group) seconds in Group B, which was statistically significant.

According to study by Erbüyün *et al*. [9] needling time of 41.60±32.62 seconds in Ultrasound guided group and 26.08 ± 15.63 seconds in conventional group was noted which was statistically significant.

However, this difference was recorded in seconds therefore; it should not be considered as a distinctive mark by the anesthesiologists.

In the present study number of puncture attempts taken in Group A (conventional method) was 1.17±0.37 and in Group B (Ultrasound guided group) 1.06±0.23, which was statistically not significant. And needle was inserted into caudal space at first attempt in 30/36 (83.33%) with conventional method and 34/36(94.4%) with ultrasound guided method. Second attempt was taken 6/36(16.66%) cases with conventional method and with ultrasound guided method it was 2/36(5.5%) cases. This was similar to ultrasound guided study conducted by Park JH 7 *et al*. in which the needle was inserted into the caudal space in 120 ⁄ 130 (92.3%) children at the first attempt, 7/130 (5.4%) children at the second attempt, and 3 ⁄ 130 (2.3%) children at the third attempt, and there were no bloody taps or accidental dural puncture.

In our study no episodes of intraoperative hypotension requiring fluid bolus; or bradycardia requiring administration of atropine, was seen in both the groups. Similar results were seen in studies conducted by Park JH *et al*. [7], Erbüyün K *et al*. [9] and Shin KM *et al*. [8] conducted a study on "Caudal epidural block in children: comparison of needle insertion parallel with caudal canal versus conventional two-step technique" by taking 75 patients aged between 0-72 months posted for below urological surgery Patients were randomly divided into two groups: a conventional method group (caudal block performed with conventional needle insertion, n=40) and a new method group (needle inserted into the skin at an angle of 20° and into the caudal space without redirection, n=35).

There is no difference with respect to number of attempts in both the groups but use of ultrasound in giving block helps in seeing real time drug spread and also helps in confirmation of epidural space.

Although the calculated angle difference between the two groups in our study is statistically significant which is not so useful clinically, use of ultrasound definitely decreases the difficulty of identifying the sacral canal which was similar to study conducted by Abukawa *et al*. [10] where they found that Ultrasound is effective for determining the depth of the epidural space and for observing expansion of the epidural space during injection of local anesthetic, However, latent vascular injection of local anesthetic is not detected by ultrasound. An excess dose of local anesthetic (1 ml/kg) is usually employed for pediatric caudal anesthesia. They used 0.25% levobupivacaine (1 ml/kg) for caudal analgesia, which was combined with 1:200000 epinephrine to avoid vascular injection and intoxication.

According to study conducted by Orme RL *et al*. [11] on "The `swoosh' test an evaluation of a modified `whoosh' test in children" by taking 113 children aged between 1-13 years who were posted for below umbilical surgeries and they found that overall success rate of caudal anaesthesia was 95.6%. of the 108 patients with a successful block, 98 had a positive "swoosh" test. There were no false positive results. Calculations show the "swoosh" test to have a sensitivity of 91%, a specificity of 100% and a positive predictive value of 100%. And they concluded that the `swoosh' test is a simple and accurate test to confirm successful caudal insertion in children, and is especially useful as a teaching aid for

anaesthetists new to the technique [12].

"Determining the accuracy of caudal needle placement in children: a comparison of the swoosh test and ultrasonography" by including 83 pediatric patients (0-11 years) presenting for elective surgery over a 4month time period he found that Ultrasonography is superior to the "swoosh" test as an objective confirmatory technique during caudal block placement in children. They found the presence or absence of turbulence during injection within the caudal space to be the best single indicator of caudal success. Ultrasonography should be used, if available, when teaching this technique Even in our study we found that ultrasonography is easier, helps in real time confirmation of epidural space with better visibility of drug spread. Ultrasound guided caudal block is more useful in sacral anatomical abnormalities than in normal.

Conclusion

We conclude that optimal angle of needle insertion during caudal epidural injection is about $20\text{-}30^0$ to the skin. With this angle the chance of performing a successful caudal injection can be increased with minimal risk of intraosseous insertion. So we suggest that ultrasound guided technique is safer and more reliable than the conventional technique. Ultrasound guidance should be considered in cases where the identification of sacral anatomy is difficult by palpation.

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